

EL NINO AND LA NINA: THE INDIAN PERSPECTIVE

Climate Dynamics and Agricultural Resilience: Analyzing El Nino and La Nina Impacts on India's Monsoon Patterns

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INTRODUCTION



El Niño Southern Oscillation (ENSO) refers to the irregular surface temperatures in the central and eastern Pacific Ocean. In direct contrast, La Niña involves the cooling of the equatorial Pacific waters. .

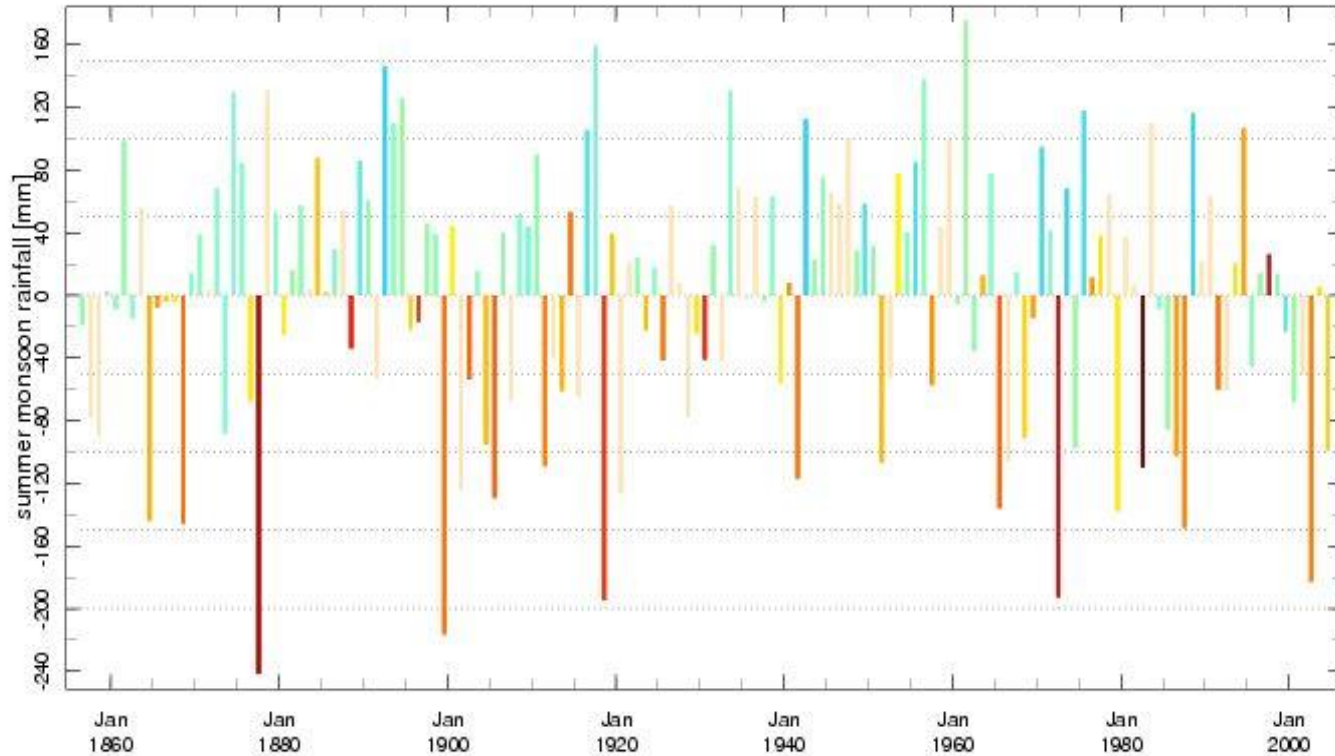


Both phenomena impact global weather patterns, with ENSO having a distinct negative impact on Indian summer monsoon rainfall (ISMR) in a predominantly agriculture-dependent economy. La Niña is generally seen to have a positive impact on Indian crops.



The primary aim of this presentation is to analyze the intensity of ENSO and La Niña and their correlation with ISMR with emphasis on its consequences on the developing economy of India, thereby enhancing predictive capabilities for monsoon variability in the country.

RESEARCH AND METHODOLOGY



Relationship between summer monsoon rainfall in India and
ENSO (Source: IRI Columbia)

- The inverse variability of ISMR with Sea Surface Temperatures (SST) is calculated on the basis of the All-India Rainfall Index.
- All the six drought years in the last 34 years were El Niño years, yet there were six El Niño years which did not convert into droughts for India.

Types of events	Since 1950s (64 years)	Since 2000s (14 years)
Global El Nino	23 years: 1951, 1953, 1957, 1958, 1963, 1965, 1968, 1969, 1972, 1976, 1977, 1982, 1983, 1986, 1987, 1991, 1992, 1994, 1997, 2002, 2004, 2006, 2009	4 years: 2002, 2004, 2006, 2009
Indian droughts	13+1: 1951, 1965, 1966, 1968, 1972, 1974, 1979, 1982, 1986, 1987, 1991, 2002, 2004, 2009	3 years 2002, 2004, 2009
Droughts and El Nino	10+1 1951, 1965, 1968, 1972, 1982, 1986, 1987, 1991, 2002, 2004, 2009	3 years: 2002, 2004, 2009
El Nino but not drought	12 years 1953, 1957, 1958, 1963, 1976, 1977, 1983, 1992, 1994, 1997, 2006	1 year: 2006
Drought but not El Nino	3 years: 1966, 1974, 1979	None

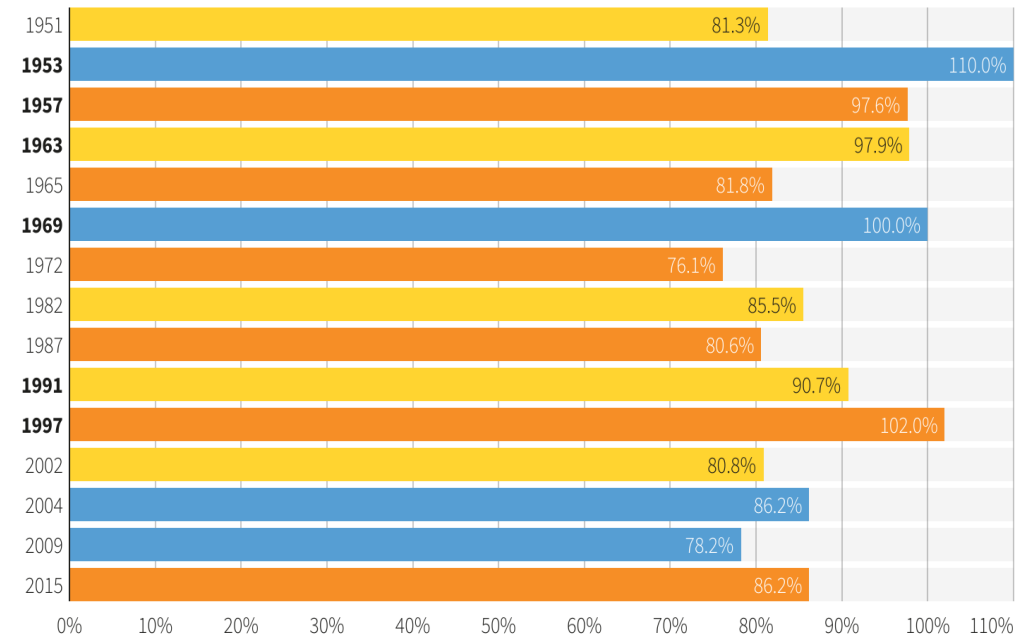
EL NINO: A DROUGHT-RIDDEN INDIA

IMPACT OF CLIMATE CHANGE

Correlation between El Nino and Indian monsoon rains

Rainfall departure between June to September.

● Weak El Nino ● Moderate El Nino ● Strong El Nino



Source: Indian Meteorological Department

- In the past 70 years, El Nino has occurred 15 times. During six of these, there was normal or above average rainfall. But a contrasting trend has emerged in the last four El Nino years, with India consistently facing drought conditions and rainfall falling below 90% of the long period average.
- In 1997, a strong El Nino occurred, yet India received 102% of its normal rainfall. In a contrast, the weak 2009 El Nino led to a significant reduction in India's rainfall, plummeting to 78.2% of normal, the lowest recorded in 37 years.
- This shows the impact of climate change as a steep pressure gradient leads to higher deflection of trade winds, and less rainfall.

LA NINA: COOLING OF THE PACIFIC WATERS

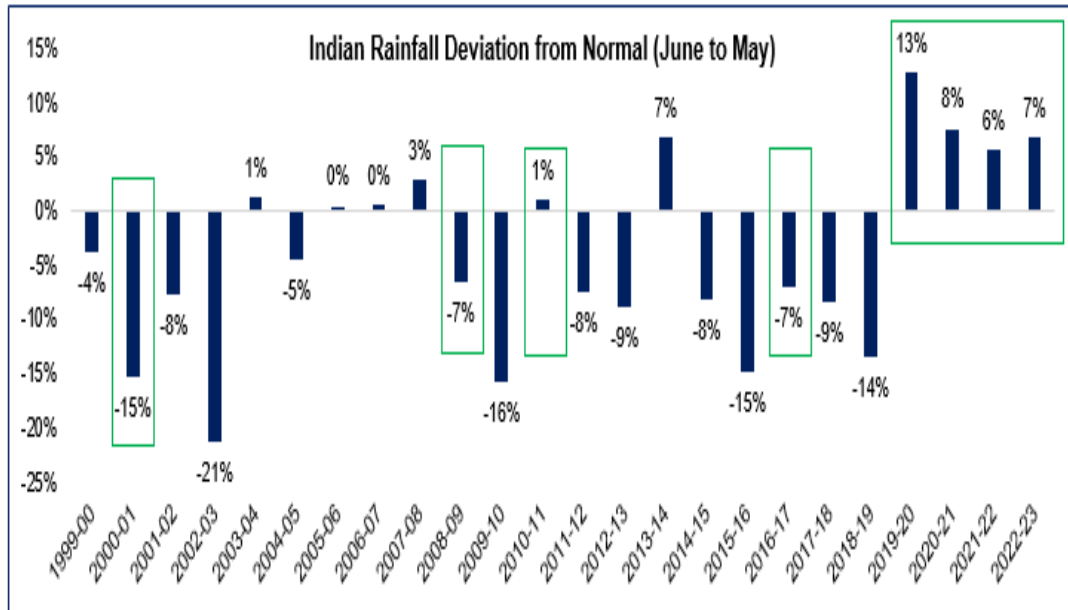


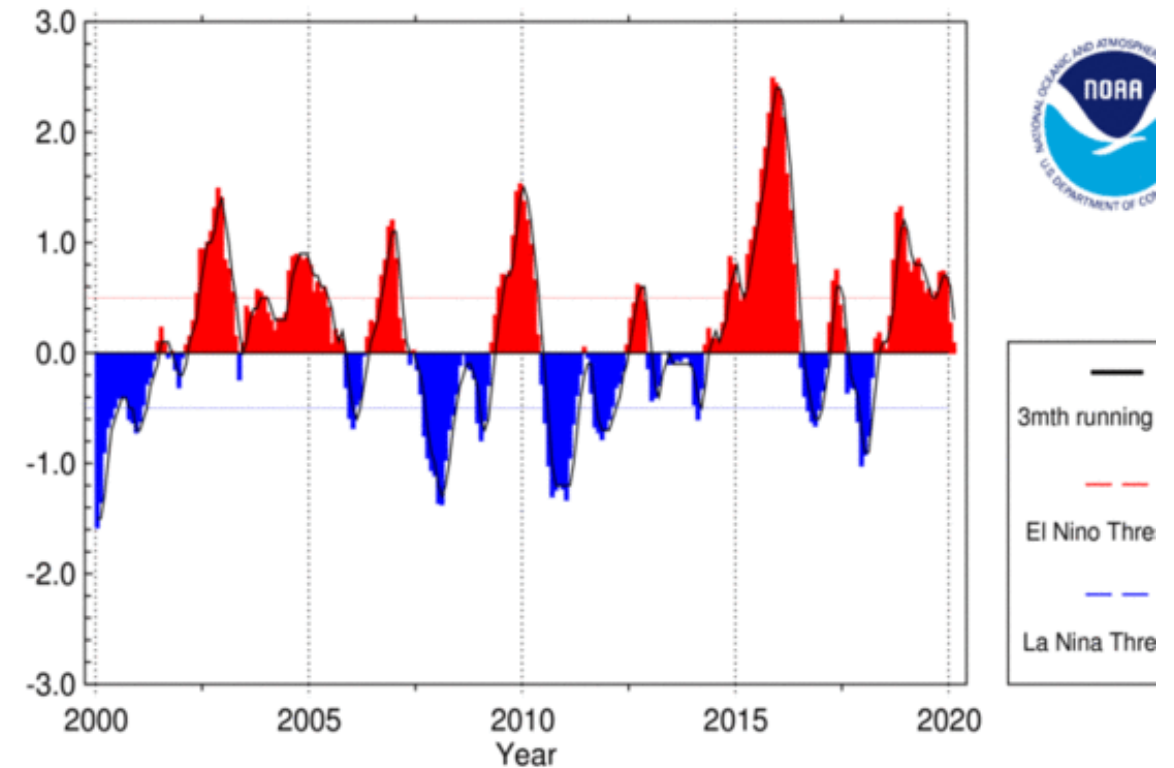
Fig 3: Percentage deviation of rainfall in the past 24 years (source: CMIE, All the green boxes indicate La Niña years)

- 70% of India’s annual precipitation is received between June and September (ISMR months).
- La Nina in recent years has brought even more rainfall to India, especially during the period of 2019-2023.

EL NINO, LA NINA AND INDIAN AGRICULTURE

- El Nino and La Nina never occur at the same time, implying that each cycle takes a significant toll on Indian crops in the affected areas.
- A 2003 study between the variability of summer monsoon rainfall (SMR) with ENSO phases in major foodgrain producing sub-divisions of India during 1950–99 concluded that El Nino years reduces foodgrain production, as SMR is a critical input for both Kharif and Rabi season crops under intensive crop production systems.

SST Anomaly in Nino 3.4 Region (5N-5S,120-170W)



National Centers for Environmental Information / NESDIS / NOAA

CYCLALITY IN AGRICULTURAL OUTPUT

El Niño, which causes a lack of rainfall, tends to reduce summer crop production of rice, sugarcane, cotton, and oilseeds, with the result being higher inflation rates and lower GDP due to the agriculture sector's significant contribution to the Indian economy.

A study conducted by Selvaraju in the 2000s saw that during 12 of the 13 warm El Niño years during 1950 to 1999, total food grain output was declined by 1.2 to 14.9%. On the other hand, total foodgrain production increased in 10 of the 13 La Nina years.

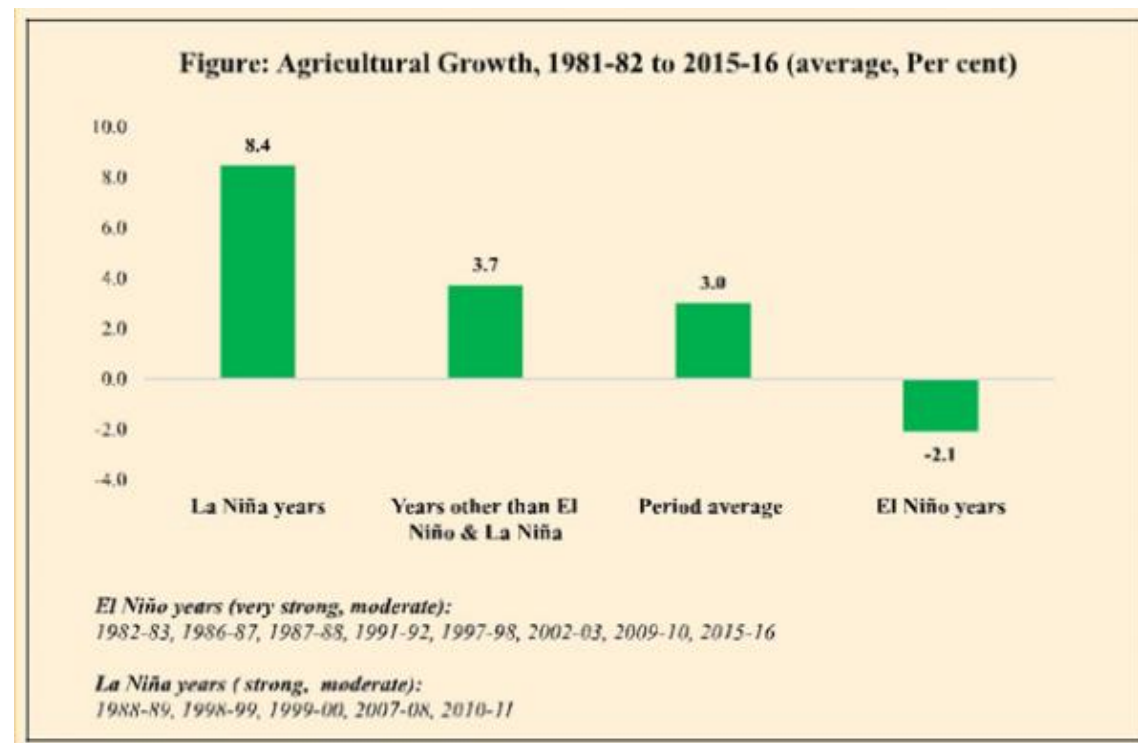
Eight out of nine El Niño years saw a decrease in kharif season food grain production, with the impact being greater on kharif food grain production than rabi season crops.

Rabi food grain production anomalies were negative in 8 of 9 El Niño years, and production was less than normal in just 4 of 10 La Nina years.

During the 1981-2006 research period, average production declined by 42.7 percent during El Niño years, and productivity decreased by 36.4 percent for crops other than rice.

COMPARITIVE GROWTH

- There was a reduction in kharif season's foodgrain production in eight out of nine El Nino years and the impact was higher on kharif foodgrain production as compared to rabi season crops.
- This is attributed to the fact that kharif crops like rice growing in ISMR months need a regular supply of monsoonal rainfall which lessens when El Nino diverts the monsoons.



Agricultural growth in El Nino and La Nina years
(source: budget 2016- Akash Agarwal)

A FUTURISTIC PERSPECTIVE

- With a La Nina event predicted to start within the next few months, it is essential for the not only the Indian government- but the ruling bodies of all affected nations with an emphasis on countries in the Indian Ocean.
- One major institutional mechanism for this purpose is the enactment of a Disaster Management Act in which the central and the subnational governments have been given specific roles.
- Similarly, over the years, buffer stocks have been developed for selected crops especially wheat and rice with a view to stabilizing their prices in the presence of supply side challenges.

- Such strategies include Minimum Support Prices (MSP) which are announced from year to year by the central government based on recommendations of the Commission for Agricultural Costs and Prices.
- The recently introduced PM Fasal Bima Yojana (crop insurance program) is also part of the overall strategy aimed at mitigating the adverse impact of crop failures.

RESULTS AND IMPLICATIONS

- The variability caused by El Niño and La Niña directly affects agricultural outcomes in India, which relies heavily on monsoon rains for crop production. Reduced rainfall during El Niño years can lead to crop failures, food insecurity, and economic distress for farmers. All this results in a significantly lower GDP for India which is hard-hitting for a predominantly rural economy whose primary mode of income and survival is agriculture of various forms.
- The government and agricultural stakeholders are urged to adopt drought mitigation strategies, including improved irrigation practices and crop diversification, to build resilience against these climatic fluctuations.
- As the relationship between ENSO events and Indian monsoon rainfall has evolved, there is a pressing need for adaptive agricultural strategies. This includes the development of climate-resilient crop varieties and enhanced water management practices to cope with the increasing unpredictability of monsoon patterns.

CONCLUSION

- El Niño and La Niña in conjunction with associated droughts and floods conditions have been demonstrated to have a considerable impact on global food grain production.
- While La Niña showing a positive impact on Indian food grain production, El Niño events have led to either below average rainfall or drought like situation that result in a reduced yield of rainfed crops.
- Greater emphasis must be given to monitoring of El Niño and La Niña in conjunction to Indian summer monsoon rainfall.
- However, El Niño is only one of several factors that influences monsoon rainfall amount, and the absence of El Niño does not always imply to good rainfall and far more thorough research needs to be conducted to understand this.

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